DOCUMENT RESUME

ED 059 690 HE 002 858

AUTHOR Spaeth, Joe L.
TITLE Undergraduate Origins and Success in Graduate School.
INSTITUTION National Opinion Research Center, Chicago, Ill.
PUB DATE Aug 66
NOTE 23p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS Academic Achievement; Academic Performance; Colleges; *Graduate Study; *Higher Education; *Performance Factors; *Success Factors; *Undergraduate Study; Universities

ABSTRACT
Much concern has been shown over possible defects in small college preparation of science majors. This paper presents data from a large-scale longitudinal survey of 1961 graduates that has a direct bearing on the relation of graduate school success to undergraduate origins. Results of the survey show that university-trained science majors are only slightly better than those from small colleges. Except for initial enrollment, chemistry majors from small schools seem to be at some disadvantage if their colleges were not particularly good or if they had mediocre records. Under these circumstances, they were less likely to enroll on a continuous basis, to plan to take the Ph.D., and to expect to take a relatively short time getting that degree if they planned to take it. For biology and physics majors only the rate of continuous enrollment was lower. In nonscientific fields college type had generally small or inconsistent effects. In nearly all fields and for most outcomes, high undergraduate academic performance was a strong predictor of graduate success. (Author/HS)

UNDERGRADUATE ORIGINS AND SUCCESS IN GRADUATE SCHOOL

by

Joe L. Spaeth

University-trained science majors do slightly better in graduate school than those from colleges

Joe L. Spaeth is a Senior Study Director, National Opinion Research Center, University of Chicago

NATIONAL OPINION RESEARCH CENTER

University of Chicago

August, 1966

In recent years several observers have concluded that undergraduate training in the sciences is best carried out in universities.[1] The form of the observation varies with the concern of the observer, but the general idea is that science majors trained in four-year colleges are at a disadvantage when they go to graduate school. Reasons for this disadvantage are thought to be connected with deficiencies in the science programs of the smaller schools. These include the following: departments are too small; they have inadequate or old-fashioned equipment; the curricula are far from up-to-date; faculty members do too little research and do not keep up with the forefront of the field.[2] Empirical data on this question have often been spotty, and the basis for the indictments of small colleges has been, as often as not, personal observation.

This paper presents data from a large-scale longitudinal survey which has a direct bearing on the relation of success in graduate school to undergraduate origins. In the spring of 1961, the National Opinion Research Center administered a questionnaire on the career plans of that year's June graduates. Questionnaires were sent out to a sample of 41,000 graduates, with an 84 per cent return. In each of the three subsequent years an additional questionnaire was mailed. Return rates (for the 41,000 denominator) were 76 per cent, 71 per cent, and 60 per cent, in chronological order.[3] The major aim of the study was to investigate graduate school plans and their fulfillment in the sciences and engineering. Students from all fields were included in the sample, however.

The thesis that the kind of college attended affects one's chances for success in graduate school has as many aspects as there are criteria of success. I have chosen four: actual enrollment in graduate school during the first year after college; enrollment during all three of the years after college graduation, if one had enrolled during the first; the expectation of receiving the Ph.D. (or equivalent); and the year the Ph.D. is expected. All items were collected during the appropriate years, and the last two were taken from the 1964 questionnaire, thus allowing time for a certain amount of "erosion by reality."

Independent variables include undergraduate major, grouped into the twelve fields shown in Table 1. From a wide range of questions pertaining to field choices, this one was chosen because it was most directly related to undergraduate preparation. A second independent variable is type of undergraduate school. These have been divided into two groups, "universities" and "liberal arts colleges." Included in "universities" are technological schools because all but one of those in the sample had graduate programs and their curricula emphasize science. Included in "liberal arts colleges" are teachers colleges because of their undergraduate character and their lack of emphasis on science. It should be noted that this group of schools is of wider scope than the small private colleges that one usually thinks of as liberal arts colleges.

The final independent variable is a measure of undergraduate academic performance. The academic performance index (API) adjusts the students' grade point average (GPA) by a measure of the college's academic calibre. Colleges were divided into four groups according to the mean scores of their 1957 freshman classes on the National Merit

Scholarship Qualifying Test. (These were estimated when not directly available.) Students from the highest group of colleges were scored as high on API if they had a GPA of at least B-. Graduates of the lowest scoring colleges needed a GPA of A- to attain the same academic performance rating. Conversely a student from a "good" college would score lower on API only if he had worse grades than a student from a poorer college. Essentially, this procedure formalizes the common practice by which graduate admissions committees take into account not only a candidate's grades but the college he attended.[4]

There are too few women in physics and chemistry for analysis, so the data reported here refer to men only. All fields are included for purposes of comparison and because certain results could throw doubt on the cogency of some of the reasons advanced regarding the liberal arts disadvantage. If, for example, humanists were found to suffer from such a disadvantage, this fact might cast doubt on the purported effects of poor equipment or lagging curricula, since equipment is not so important in the humanities and it is hard to think of a revolution in this field that has required a drastic revision in the curriculum.

API is included to avoid confounding an institutional effect with the ability of the students themselves. A study of MIT graduate physics alumni cited by the Committee on Physics Faculties in Colleges shows that physics graduate students who came from MIT's top twenty "competitors" performed better at MIT than graduates of other colleges.[5] This is hardly surprising. Not only are MIT's competitors outstanding universities (the lowest of the 20 physics departments ranked 34 in the recent ACE survey),[6] but the students from these schools were doubtless

brighter than their peers from smaller schools. Institutions with the best graduate departments probably tap the best students for their undergraduate programs. Recent studies assessing colleges on the basis of their graduates' achievements have made it amply clear that a control for student input characteristics is essential.[7] In other words, did MIT's competitors do an outstanding educational job, or were they just pumping stations for the brightest students? At this juncture, the weight of the evidence seems to favor the pumping station approach.[8]

Results will be reported only for respondents who returned all four questionnaires. The biases introduced by this procedure are negligible. Only some of the items presented here were used in an assessment of bias, but, of those, differences between the all-four-years group and all respondents who could have answered the question were: .1 per cent too few men, 1.9 per cent too many persons with high API, and 1.2 per cent too many who had enrolled in graduate school during the first year after graduation. We have not yet been able to analyze the differences between those who returned 1961 questionnaires and those who did not, however.

Table 1 is presented to give some idea of the standing of the twelve fields on the two crucial variables. "High" API refers to the highest of three categories; it includes one-fifth of the sample. Physics, chemistry, mathematics, and the humanities are well above average on API, with education, business, and the miscellaneous fields well below. A different set of fields is extreme on type of college. Men in health, other physical sciences, and engineering were most likely to have gone to universities (or technological colleges). Liberal arts colleges attracted persons in education, the biological sciences, and, perhaps surprisingly, chemistry.

The findings for the four dependent variables will be presented as net partial coefficients of association. Yet the level of attainment or aspiration varies considerably from field to field. Table 2 therefore shows the levels on each of the dependent variables for each of the twelve fields. On the average, 42 per cent of the men had enrolled in graduate school immediately after leaving college. In general, fields leading to academic or medical careers are highest on immediate enrollment. Though physics, chemistry, and biology rank above the social sciences and humanities, all are well above average. Health is the only other field above average (presumably owing to premedical students), and business is the only field appreciably below average.

Assuming that the most desirable outcome of graduate enrollment is the doctorate and that the most expeditious path to that degree is continuous enrollment, data on continuity of enrollment are presented in the second column of Table 2. Among men who had become graduate students during the year following college graduation, 60 per cent had been enrolled for all three years. The sciences and health are well above average, the social sciences and humanities about average, and the remaining fields below average. Medicine's tight curriculum and heavy stipend support in the sciences may help to account for their greater staying power compared with the social sciences and the humanities. Of course, in some fields the Ph.D. is a requisite for professional standing, and continuous enrollment is the quickest way to get that degree. These are the fields in which continuous enrollment is most frequent.

The expectation of receiving the Ph.D. is highest in physics and chemistry and somewhat above average in the remaining arts and science fields. Business, health, and education are, naturally enough, low. In general, these findings, like the previous ones, are in accord with the occupational requirements of each of the fields.

The last column of the table shows the percentage expecting to receive the Ph.D. by the end of 1966. Chemists expect the fastest progress, with mathematicians and physicists next. The other natural scientists are above average, but the social scientists and humanists are not. These expectations may be optimistic, since they imply shorter time lapses than actual data on Ph.D. attainment would indicate. However, the fields in which students expect to take their Ph.D.'s most rapidly are also those in which enrollment is most likely to be continuous. For men who can stay in graduate school until they get the Ph.D., these estimates may not be far from reality.[9]

The foregoing information on levels of graduate attainment and aspiration helps to place the institutional effects problem in a broader perspective. Physics and chemistry, the fields in which the issue appears to be most salient, are among the fields highest on these indicators of success in graduate school. In comparison with the other fields, therefore, the effects of institutional type and academic performance will only add to an already high level of achievement.

Institutional Type and Academic Performance

The institutional effects thesis will be tested by showing the relation between each of the four success criteria and college type, net of academic performance. For purposes of comparison, the relation be-

tween the criterion and academic performance, net of college type, will also be given. The measure of association used is Yule's Q, with a partialling procedure developed by James A. Davis.

Q has the following properties. If you are asked to predict whether a dichotomous event will be "positive" (A) or "negative" (not-A) and given no further information, you can do no better than guess. If, for every pair of cases that differ with regard to attribute A (one is A and the other not-A), you are told that one member is B and the other not-B, you may be able to use your knowledge of the B-state of the cases to predict their A-state. Q is a direct measure of the extent to which knowledge of B <u>improves</u> prediction of A. If B is irrelevant, you can still do no better than guess, and Q will be 0. If all B's are A's, prediction is improved 100 per cent, and Q will be 1.00. If the absence of B perfectly predicts A, Q will be -1.00.

Of course, the "effect" of B on A may be owing to a third factor, C, which is correlated with A and B. The appropriate test for this possibility is to examine the relation between A and B under the conditions C and not-C. If the original relation disappears, the B "effect" stems from C. The partialling procedure used here is "net" because it averages the effects of C and not-C (high and low API, for example) in a manner analogous to that of the partial product-moment correlation.[10]

Since no significance tests have been developed for net partial Q's, a procedure based on chi-square has been used. In assessing the significance of a university advantage on enrollment, for example, the chi-square for the relation of college type to enrollment in the high API group is added to that in the low API group within each field. This summed chi-square has two degrees of freedom, and its statistical signifi-

cance is judged accordingly.[11] Q's are shown in Tables 3-6, with the .01 level of significance indicated. Since responses from some schools in the sample had to be weighted to make the sample correspond to a straight probability sample, this is not as stringent a criterion of significance as it seems to be.

Table 3 shows the relation between college type and initial enrollment in graduate school. Clearly, the effects of institutional type are negligible in physics and chemistry, as in other fields. High academic performance, on the other hand, is associated with high rates of enrollment. In brief, men with high API were much more likely to go to graduate school than those with low API, but the kind of college they attended was essentially irrelevant.

That college graduates apply to and are accepted by graduate schools without regard to the kind of college they attend speaks to only one aspect of the problem, however. Pake, though he claims that physics graduates from four-year colleges have difficulty in gaining admission to Stanford, also says that they tend to have trouble even if they are admitted.[12] If this observation is true, students from four-year colleges might well find it harder to enroll on a continuous basis, or they might be so discouraged that they drop out altogether. In any case, their rate of continuous enrollment might be lower than that for their counterparts who had taken their undergraduate training in a university. Table 4 shows that this is true of physics, biology, and, to some extent, chemistry majors but not of social scientists or humanists. The bottom section of the table breaks down the net partial Q's for those fields of particular interest or those showing a significant university advantage. In both chemistry and physics, the university advantage holds

only for men with low API scores. Only those who attended poorer liberal arts colleges, who had low grades or both were less likely to be enrolled on a continuous basis. The same is not true of biological scientists. Academic performance does not alter the university advantage in these fields.

Data for Ph.D. expectations are much like those presented earlier, as Table 5 shows. Attendance at a university seems to be of some benefit for majors in chemistry, mathematics, and engineering. It may even be detrimental in the social sciences and health. In any event, high academic performance is generally a much better predictor of plans to take the Ph.D. than attendance at a university. (In chemistry, the two attributes are both moderately weak in predictive power.) In contrast to other tables, the university advantage is stronger among the high API chemists than among those with lower scores. The reverse is true of the mathematicians.

University-trained chemistry graduates are much more likely to expect to get their Ph.D.'s quickly than those trained in liberal arts colleges (Table 6). So are former humanities majors. The university-trained chemists' advantage amounts to only a year, however, and the humanities' showing seems somewhat hard to interpret. In general, the API advantage is greater than the university one. Among the chemistry majors, only those liberal arts graduates with low API expected to take a relatively long time to get their Ph.D.'s. Both academic performance groups in the humanities expected to take longer if they had done their undergraduate work in a liberal arts college.

Discussion

The data reported here have neither completely supported nor completely contradicted the criticisms of small-college science training, though they tend to contradict them. Except for initial enrollment, chemistry majors from small schools seem to be at some disadvantage if their colleges were not particularly good or if they had made mediocre records. Under these circumstances, they were less likely to enroll on a continuous basis, to plan to take the Ph.D., and to expect to take a relatively short time getting that degree if they planned to take it. Low API physics majors from liberal arts colleges, on the other hand, are at a disadvantage only in suffering some interruption in graduate enrollment. There was no such disadvantage for high API liberal arts physicists.

In the scientific fields in which a university bachelor's degree seemed to be an advantage, its benefits were largely confined to men who had attended relatively poor schools or who had made relatively poor records. In effect, this finding emphasizes the positive advantages of high academic performance for success in graduate school. The importance of API is hardly surprising. Graduate departments select candidates for their academic promise on the basis of their past performance. The assertion that one has to look hard to find a university advantage may be an exaggeration, but it contains more than a grain of truth.

A brief discussion of the flow of talent through American educational institutions will serve to put the findings in further perspective. Before a student even gets to college he encounters one of the system's most notable characteristics. It is a vast talent screen.

In high schools bright children are put in academic tracks. The smarter ones are more likely to go to college than the dullards, and the smartest of all tend to go to the best colleges. It is necessary to add that, up to college entrance at least, parental socio-economic status has a great deal to do with a person's educational destiny. Children from wealthier families are more likely to go to college, and to a better one, than children from the wrong side of the tracks. The effects of aptitude and socio-economic status appear to be about equal on college going.[13]

Attendance at graduate or professional schools is conditioned not only by the institution's selectivity but by self-selection on the part of the candidates themselves. Those with better grades and from better schools are more likely to want to go to graduate school, to plan to do so, and to be allowed to do so. Among the 1961-62 physical science graduate students in this sample with college grades of B or better, 68 per cent of the graduates of the top schools had enrolled in one of Berelson's top twelve graduate institutions, but only 10 per cent of those with the same grades had done so if they came from one of the bottom colleges. In the physical sciences a grade average of at least B is almost a necessary condition for entry into one of the best graduate schools. Given this level of attainment, students from the best colleges have a large advantage over graduates of less eminent institutions.[14]

These findings do not take into account the distinction between universities and liberal arts colleges. The data reported here as well as those from other studies indicate that the intellectual calibre of a student body is a far stronger predictor of success in graduate school or plans for the Ph.D. than institutional type. The explanation for

gross differences between the two types of school in such matters as Ph.D. attainment seems to be a function of the talent mix in the two types of schools. When one thinks of specific liberal arts colleges, schools like Antioch, Oberlin, Reed, and Swarthmore come to mind. (I chose these colleges because they are "overproductive" of Ph.D.'s even when intelligence, sex, and undergraduate major are taken into account.)[15] These four schools are highly selective, and the performance of their graduates at least matches that of the products of any university. They do not enroll many students, however, and a list of their peers would be rapidly exhausted. Most liberal arts colleges cannot hope to match the selectivity of the prestigious ones. Many are less selective than universities. The graduates of many do less well in graduate school than university products. Most of the differences between the two types of institutions seem to stem from initial differences in selectivity.

Of course this is no reason for not trying to improve the quality of the many struggling liberal arts colleges. Providing a better education to a good many students is not a goal to be slighted. It is at least questionable, however, whether any immediate improvement in the calibre of science graduate students would result, particularly in the exalted domains of the prestigious giants.

Summary

Much concern has been shown over possible defects in small-college preparation of science majors. Data from a large-scale longitudinal survey of 1961 college graduates shows that these concerns are justified

to a limited extent regarding some outcomes of graduate enrollment in some fields. Initial enrollment was not affected by the type of college attended. In chemistry continuous enrollment, plans for the Ph.D., and time expected to be spent in getting that degree were higher among men who had gotten their bachelor's degrees in universities if they came from unselective schools or had poor grades. In physics and biology only continuous enrollment was higher. In nonscientific fields college type had generally small or inconsistent effects. In nearly all fields and for most outcomes, high undergraduate academic performance was a strong predictor of graduate success.

References and Notes

1. Committee on Physics Faculties in Colleges (COPFIC), Physics Today, 17; 36-40, 1964, and Toward Excellence in Physics, New York, 1964. H. A. Barton, R. B. Lindsay, and L. O. Olsen, Physics Today, 15, 48, 1962. G. E. Pake, American Journal of Physics, 29, 678-684, 1961. P. M. Morse and G. F. Koster, Physics Today, 14, 22, 1961. A. F. Scott, Chemical and Engineering News, 43, 96-108, 1965. Dael Wolfle, Science, 153, 697, 1966.
2. Pake, ibid., American Journal of Physics, 29, 680, 1961.
3. For a description of the sample, see J. A. Davis, Great Aspirations (Aldine Publishing Co., Chicago, 1964), pp. 269-294.
4. For further details, see J. A. Davis, ibid., pp. 26-31 and 256-268.
5. P. M. Morse and G. F. Koster, ibid., Physics Today, 13, 22, 1961.
6. A. M. Cartter, An Assessment of Quality in Graduate Education (American Council on Education, Washington, D. C., 1966), p. 68.
7. A. W. Astin, Science, 136, 129-135, 1962, and Science, 141, 334-338, 1963, and J. L. Holland, Science, 126, 433-437, 1957.
8. A. W. Astin, ibid., Scicnce, 136, 129-135, 1962.
9. L. A. Harmon, Doctorate Production in United States Universities, 1920-1962 (National Academy of Sciences--National Research Council, Washington, D. C., 1963), pp. 40-43. Bernard Berelson, Graduate Education in the United States (McGraw-Hill Book Co., Inc., New York, 1960), pp. 156-162.
10. Q is defined in G. U. Yule and M. G. Kendall, An Introduction to the Theory of Statistics (Charles Griffin and Co., London, 1958), p. 30. A statistical interpretation of the measure is given in L. A. Good-

man and W. H. Kruskal, Journal of the American Statistical Association, 49, 732-764, 1954, where Q is shown to be a special case of their gamma. A net partial Q has been developed by J. A. Davis, "A Net Partial and a Multiple Coefficient for Goodman and Kruskal's Gamma," National Opinion Research Center, November, 1964, processed.

Q can be defined from the following four-fold table:

	B	$\bar{B}$
A	AB	$A\bar{B}$
$\bar{A}$	$\bar{A}B$	$\bar{A}\bar{B}$

$$Q = \frac{(AB)(\bar{A}\bar{B}) - (A\bar{B})(\bar{A}B)}{(AB)(\bar{A}\bar{B}) + (A\bar{B})(\bar{A}B)}$$

The cell entries here are logical products, i.e., AB's are those cases that are both A and B and $A\bar{B}$ those cases that are A but not B. The net partial has the same form, but the cross product terms are summed over the two-by-two tables formed by each category (i) of a third variable:

$$Q_{NP} = \frac{\sum_{i=1} (AiBi)(\bar{A}i\bar{B}i) - (Ai\bar{B}i)(\bar{A}iBi)}{\sum_{i=1} (AiBi)(\bar{A}i\bar{B}i) + (Ai\bar{B}i)(\bar{A}iBi)}$$

11. H. M. Blalock, Jr., Social Statistics (McGraw Hill Book Co., Inc., New York, 1960), pp. 238-239.
12. G. E. Pake, ibid., American Journal of Physics, 29, 679, 1961.
13. J. K. Folger and C. B. Nam, A Study of Education and the Social Structure (Florida State University, 1965), pp. 46-50 and John A. Michael, Public Opinion Quarterly, 25, 595, 1961.
14. For the correlates of plans for graduate school, see J. A. Davis, Great Aspirations, op. cit., pp. 80-100. For the extent to which

these plans are realized, see Norman Miller, One Year After Commencement (National Opinion Research Center, Chicago, 1963, multilithed), pp. 9-11. The data on undergraduate origins and graduate destinations are from an unpublished analysis by Norman Miller.

15. A. W. Astin, Science, 136, 134, 1962. For an untoward effect of colleges' emphasis on the selection and grading of talented students, see J. A. Davis, American Journal of Sociology, 72, 17-31, 1966.

The research reported here was supported through the Cooperative Research Program of the Office of Education, U. S. Department of Health, Education, and Welfare, under Contract SAE -9102, and by the National Institutes of Health under Grants M5615, M5615-02, M5615-03, M5615-04 and M5615-05. I should like to thank Dr. David Z. Robinson of the Office of Science and Technology and Dr. Arthur F. Scott of Reed College for their many helpful comments.

TABLE 1

DISTRIBUTION OF ACADEMIC PERFORMANCE AND SCHOOL ATTENDANCE BY UNDERGRADUATE MAJOR (MEN ONLY), 1961 SAMPLE

Major	Per Cent High on Academic Performance	Per Cent Who Attended a University as Undergraduates	Number of Men
Physics	49	58	(511)
Chemistry	28	39	(773)
Mathematics	30	47	(579)
Other physical sciences	21	69	(279)
Biological sciences .	20	43	(810)
Engineering	21	87	(3,213)
Social sciences . . .	23	49	(2,246)
Humanities	30	47	(2,267)
Health	26	64	(574)
Education	8	23	(2,622)
Business	10	53	(3,813)
Other	14	61	(1,459)
All fields	19	54	(19,146)[a]

[a]Students in the large undergraduate institutions were oversampled, leaving some of the smaller schools underrepresented. Responses from the smaller colleges have been weighted so that the sample corresponds to a straight probability one.

TABLE 2

RELATION OF INITIAL GRADUATE SCHOOL ENROLLMENT, THREE-YEAR GRADUATE SCHOOL ENROLLMENT, 1964 PLANS FOR THE PH.D. AND DATE PH.D. IS EXPECTED TO UNDERGRADUATE MAJOR (MEN ONLY)

Major	Per Cent Enrolled In Graduate School Right After College		Per Cent Enrolled For Three Consecutive Years If Enrolled During First Year		Per Cent Expecting To Receive a Ph.D.[a]		Per Cent Expecting To Receive Ph.D. by 1967, Among Those Expecting Ph.D.[b]	
Physics	73	(517)[c]	74	(371)	63	(510)	68	(259)
Chemistry	65	(782)	79	(501)	44	(781)	81	(281)
Mathematics	53	(590)	58	(313)	32	(587)	70	(135)
Other physical sciences .	45	(280)	63	(114)	33	(281)	63	(72)
Biological sciences . . .	70	(829)	79	(581)	28	(828)	55	(184)
Engineering	36	(3,248)	51	(1,145)	16	(3,235)	51	(356)
Social sciences	56	(2,255)	64	(1,259)	26	(2,249)	47	(377)
Humanities	58	(2,285)	63	(1,323)	31	(2,265)	41	(465)
Health	61	(590)	84	(346)	10	(588)	40	(35)
Education	38	(2,685)	56	(994)	27	(2,662)	14	(441)
Business	19	(3,862)	40	(733)	5	(3,843)	28	(102)
Other	32	(1,495)	47	(458)	14	(1,479)	37	(122)
All fields	42	(19,692)	61	(8,138)	22	(19,577)	48	(2,870)

[a]This question was asked of all respondents and is so reported.

[b]This question was asked only of those enrolled during the 1963-64 academic year.

[c]Numbers in parentheses are the number of cases in each cell.

TABLE 3

RELATION OF MEN'S ACADEMIC PERFORMANCE AND TYPE OF COLLEGE TO ENROLLMENT IN GRADUATE SCHOOL IMMEDIATELY AFTER GRADUATING FROM COLLEGE BY COLLEGE MAJOR (NET PARTIAL Q)

Major	Type of College, Controlling Academic Performance[a]	Academic Performance Controlling Type of College
Physics	-.05	.63[b]
Chemistry	.00	.58[b]
Mathematics	.08	.49[b]
Other physical sciences	.03	.53[b]
Biological sciences	.18	.77[b]
Engineering	.11[b]	.64[b]
Social sciences	-.04	.43[b]
Humanities	.02	.48[b]
Health	-.16	.42[b]
Education	.06	.23[b]
Business	.14[b]	.48[b]
Other	-.06	.59[b]
All fields	.06[b]	.53[b]

[a]A university advantage yields a positive Q.

[b]Chi-square significant at the .01 level.

TABLE 4

RELATION OF TYPE OF COLLEGE AND ACADEMIC PERFORMANCE TO ENROLLMENT IN GRADUATE SCHOOL IN EACH OF THE FIRST THREE YEARS AFTER GRADUATION BY COLLEGE MAJOR, AMONG MEN WHO HAD ENROLLED IMMEDIATELY AFTER GRADUATION (NET PARTIAL Q)

Major	Type of College, Controlling Academic Performance[a]	Academic Peformance, Controlling Type of College
Physics	.35[b]	.42[b]
Chemistry	.33	.74[b]
Mathematics	.01	.57[b]
Other physical sciences	-.13	-.03
Biological sciences	.51[b]	.56[b]
Engineering	.11	.03
Social sciences	.13	.35[b]
Humanities	.04	.21[b]
Health	-.40	.03
Education	-.04	-.16
Business	.13	.22
Other	.09	.24
All fields	.09[b]	.18[b]

Partial Q's corresponding to net partial Q's indicating a university advantage in continuous enrollment for fields of particular interest.[c]

Major	High Academic Performance	Low Academic Performance
Physics	.09	.60[b]
Chemistry	-.17	.38[b]
Biological sciences	.45[b]	.51[b]

[a] A university advantage yields a positive Q.

[b] Chi-square significant at the .01 level.

[c] Engineering is excluded because there are too few cases in liberal arts colleges.

TABLE 5

RELATION OF TYPE OF COLLEGE AND ACADEMIC PERFORMANCE TO PLANS FOR PH.D., THIRD YEAR AFTER GRADUATION, BY COLLEGE MAJOR AMONG ALL MEN (NET PARTIAL Q)

Major	Type of College, Controlling Academic Performance[a]	Academic Performance Controlling Type of College
Physics	.16	.65[b]
Chemistry	.22[b]	.27[b]
Mathematics	.33[b]	.57[b]
Other physical sciences	-.33	.50[b]
Biological sciences	-.18	-.02
Engineering	.28	.64[b]
Social sciences	-.12[b]	.27[b]
Humanities	-.11	.44[b]
Health	-.40	.48[b]
Education	-.03	.40[b]
Business	-.04	.51[b]
Other	-.17	.28[b]
All fields	-.02[b]	.50[b]

Partial Q's corresponding to net partial Q's indicating a university advantage, or for fields of particular interest.[c]

Major	High Academic Performance	Low Academic Performance
Physics	.26	.09
Chemistry	.42[b]	.19
Mathematics	.18	.37[b]

[a]A university advantage yields a positive Q.

[b]Chi-square significant at the .01 level.

[c]Engineering is excluded because there are too few cases in liberal arts colleges.

TABLE 6

RELATION OF TYPE OF COLLEGE AND ACADEMIC PERFORMANCE TO EXPECTATION OF THE PH.D. BY 1967 BY COLLEGE MAJOR, AMONG MEN WHO PLANNED ON TAKING A PH.D. AND WERE IN GRADUATE SCHOOL DURING 1963-1964 (NET PARTIAL Q)

Major	Type of College, Controlling Academic Performance[a]	Academic Performance Controlling Type of College
Physics	.19	.63[b]
Chemistry	.52[b]	.50
Mathematics	-.20	.73[b]
Other physical sciences	.18	c
Biological sciences	-.07	.65[b]
Engineering	c	.31
Social sciences	.21	.62[b]
Humanities	.38[b]	.65[b]
Health	c	c
Education	.23	.60[b]
Business	.28	c
Other	.77[b]	.40[b]
All fields	.31[b]	.53[b]

Partial Q's corresponding to net partial Q's indicating a university advantage for expecting the Ph.D. prior to 1967.[d]

Major	High Academic Performance	Low Academic Performance
Physics	.21	.11
Chemistry	.30	.55[b]
Humanities	.34[b]	.44[b]

[a] A university advantage yields a positive Q.

[b] Chi-square significant at the .01 level.

[c] Too few cases for reliability.

[d] Engineering and "other" are excluded.